REMARKS

Claims 1, 2, 4, 6-8, 10-18, 20-25, 27 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Porte, p., "Benefits of Electrical Propulsion for Orbit Injection of Communication Spacecraft", in view of Tilley et al 6,186,446.

The Examiner states that as per claims 1, 6, 7, 8, 10, 11, 14, 15, 17, 18, 20, 21, 22, 23, 24, 25, 27 and 28, Porte discloses launching a spacecraft with chemical and electrical propulsion and a solar array on page 6, section 3.4.3; firing the chemical propulsion at the apogees of the intermediate orbits, starting from the transfer orbit initiated by the launch vehicle, to successively raise perigees of the orbit until the spacecraft perigee substantially clears the Van Allen radiation belts, and where the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of a final orbit, and where the inclination of the intermediate orbit is substantially greater than the inclination of the final orbit on page 2, section 3.1, strategy 3; firing the electric thrusters to raise the orbit of the spacecraft from the orbit achieved by the chemical thrusters firing step to near geosynchronous orbit by steering the thrust vector both in-plane and out-of-plane while rotating the spacecraft body and steering the solar array to maintain the solar while rotating the spacecraft body and steering the solar array to maintain the sun's illumination on the solar array while not maintaining an earth facing panel on page 2, section 3.1, strategy 3; and selectively firing the chemical thruster to achieve geosynchronous orbit on page 2, columns 1-2; pointing the thrust away from the center of mass is inherent.

The Examiner does, however, admit that Porte does not disclose not maintaining the solar array rotation axis aligned with the orbit normal; the thruster firing profile is generated, and the spacecraft can be controlled on-board or from the ground; the step of firing the electric thruster is revised to compensate for disturbances; using momentum wheels; thrusters are differentially fired away from the center of mass for control torque and using thruster on the north and south side of the spacecraft to decrease the duration of the orbit raising phase. The Examiner goes on to state that Tilley et al teach of not maintaining the solar array rotation axis aligned with the orbit normal on lines 20-35, on column 3; the thruster firing profile is generated, and the spacecraft can be controlled on-board or from the ground on line 65, on column 2, through line 5, on column 3; and the step of firing the electric thruster is revised to compensate for disturbances on lines 2-5, on column 3; using momentum wheels on lines 55-57, on column 3; thrusters are differentially fired away from the center of mass for control torque and using thruster on the north and south side of the spacecraft to decrease the duration of the orbit raising phase on lines 1-3, on column 3; and a throttle back mode on lines 28-29, on column 3.

The Examiner concludes that it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the teachings of Tilley et al in the

invention of Porte because such modification would optimize thrust efficiency as disclosed in the background of Tilley et al.

Applicants respectfully submit that at the recited passages relied upon by the Examiner in Porte at page 6, section 3.4.3, although there is a general discussion of the spacecraft injected on a subsynchronous transfer orbit with the perigee raised by CPS firing up to 15,000 km, it is then stated "The EPS is then operated on an elliptical orbit with increasing semi-major axis until the apogee reaches the geosynchronous altitude. The final circularization is then obtained by CPS firing." Applicants respectfully point out that there is no mention of a solar array in this specific strategy and more significantly, no teaching of firing the chemical propulsion thrusters at apogees of intermediate orbits....to successively raise perigees of the orbit until the spacecraft perigee substantially clears the Van Allen radiation belts. Applicants respectfully point out that no where in this teaching in Porte is there any discussion whatsoever of the spacecraft perigee substantially clearing the Van Allen radiation belts. Furthermore, Applicants respectfully contend there is no teaching that the semi-major axis of the intermediate orbit is substantially less than the semi-major axis of a final orbit nor where the inclination of the intermediate orbit is substantially greater than the inclination of the final orbit as required inter alia by element 2 of claim 1. Furthermore, Applicants respectfully submit there is no teaching whatsoever that the inclination of the intermediate orbit is substantially greater than the inclination of the final orbit on page 2, section 3.1, strategy 3 as contended by the Examiner. On the contrary, Applicants respectfully contend there is disclosed "A possible approach consists in maintaining the standard injection scenario in GTO. After a perigee raising maneuver using CP up to a certain altitude, the Electric Propulsion System (EPS) is operated around apogee to raise perigee up to geosynchronous altitude. This approach presents the following inconvenients:"....Further, Applicants contend that although on page 2, section 3.1, strategy 3 there is a discussion of firing the electric thrusters to raise the orbit of spacecraft from the orbit achieved by the chemical thrusters firing step to near geosynchronous orbit, there is no suggestion, teaching or implication that such a maneuver should be employed by "steering the thrust vector both in-plane and out-of-plane while rotating the spacecraft body and steering the solar array to maintain the sun's illumination on the solar array" as required by element 3 of claim 1. Applicants further respectfully contend that although on page 2, section 3.1, strategy 3 there is taught "The EPS is then operated continuously on an elliptical orbit with increasing semi-major axis until the apogee reaches the geosynchronous altitude. The circularization is then obtained with CP. The inclination correction is shared between the two CPS burns and the EPS transfer phase in order to maximize the BOL mass.", there is no specific teaching of fired selected ones of the chemical and electric propulsion thrusters to achieve final geosynchronous orbit as

required inter alia by element 4 of claim 1. Further, although Applicants respectfully submit that they do necessarily agree that pointing the thrust away from the center of mass is inherent, this does little to cure the above noted deficiencies.

Applicants gratefully acknowledge that, as the Examiner admits, Porte does not disclose not maintaining the solar array rotation axis aligned with the orbit normal.

Applicants respectfully submit that in Tilley et al at lines 20-35 of col. 3 there is disclosed "The operational profile of the EPS is designed so that the magnitude of the thrust generated by the EPS be near constant and that the thrust attitude be continuously adjusted to optimize the direction of the thrust vector 8 for an efficient orbital transition as the satellite moves around each orbit." Applicants respectfully contend that this teaching in no way suggests or implies not maintaining the solar array rotation axis aligned with the orbit normal as contended by the Examiner. Applicants respectfully submit that at col. 2, line 65 through col. 3, line 5 there is taught "The attitude control module 10 receives current attitude data from inertial reference sensors 11 and compares it to the mission profile specified by ground controller 12....Attitude control module 10 calculates attitude adjustments and actuates the appropriate mechanism to accomplish the adjustment." Applicants respectfully submit that this does not teach the firing profile is generated and the spacecraft can be controlled onboard or from the ground as contended by the Examiner. Further, Applicants respectfully submit that the step of firing electric thruster is revised to compensate for disturbances is not taught, as contended by the Examiner, at lines 2-5 of col. 3. Further, Applicants respectfully submit that the use of momentum wheels as set out at lines 55-57 of col. 3 of Tilley et al does little to cure these deficiencies and does not teach, suggest or imply performing the step of firing the electric propulsion thrusters to raise the orbit of the spacecraft comprising adjusting attitude steering profiles using a plurality of momentum wheels as required inter alia in claim 17. Furthermore, Applicants respectfully disagree that at col. 3, lines 1-3 there is taught thrusters that are differentially fired away from the center of mass for control torque and using thruster on the north and south side of the spacecraft to decrease the duration of the orbit raising phase, as contended by the Examiner, at said passages. All that is taught at lines 1-3 of col. 3 of Tilley et al is that "Attitude may be adjusted by a series of adjusters which may include chemical thrusters 2-4, EPS thrusters 5, and momentum wheels (not shown)." which does not in any way teach the limitations as set out inter alia in claim 22. Finally, Applicants respectfully submit that the throttle back mode, as contended by the Examiner at lines 28-29 of col. 3, is merely a teaching that "It is understood that, for the purpose of this invention, it may be feasible to vary the EPS thrust magnitude." which does not teach, suggest or imply the limitation inter alia of claim 14 with regard to throttle back mode.

For these reasons, Applicants respectfully submit that they cannot agree that it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the teachings of Tilley et al in the invention of Porte because such modification would optimize thrust efficiency as disclosed in the background of Tilley et al.

The Examiner states as per claim 2, Porte discloses the thrust vector is maintained substantially normal to the axis of the solar array and the sun is normal to the solar array on page 2, column 2, paragraph 3 in section 3.2. Applicants respectfully submit that on page 2, column 2, paragraph 3 in section 3.2 there is merely disclosed "The only flight configuration compatible with these two requirements is a three axis configuration with the solar array rotation axis aligned with the orbit normal." Applicants respectfully submit that this does not teach, suggest or imply the limitation present in claim 2 requiring that the thrust vector is substantially normal to the axis of the solar array and the sun is maintained substantially normal to the solar array.

As per claim 4, the Examiner states that Porte discloses that the transfer orbit is subsynchronous on page 2, section 3.1, strategy 3.

Although Applicants do not necessarily agree, as contended by the Examiner, that the transfer orbit is subsynchronous as set out on pages 2, section 3.1, strategy 3, Applicants respectfully submit that claim 4 is patentably distinguishable over Porte for those reasons cited inter alia with regard to claim 1.

The Examiner goes on to state that as per claims 12 and 13, Porte discloses a hybrid propulsion system to use both chemical and electric propulsion to achieve a final geosynchronous orbit in Fig. 1, strategy 3, and in section 3.4.3.

Applicants respectfully submit that although in Porte Fig. 1, strategy 3 both an EPS and CP system are disclosed which the Examiner characterizes as a hybrid propulsion system, this does not teach, suggest or imply the limitation as set out in claim 12 requiring the step of firing the electric propulsion thrusters to raise the orbit of the spacecraft is completed prior to reaching a desired on-orbit location whereupon chemical propulsion thruster firings are used to guide the spacecraft to the final desired orbit position to compensate for disturbances experienced by the spacecraft. Further, in section 3.4.3 Applicants respectfully submit there is a broad ranging discussion of the spacecraft injected on a subsynchronous transfer orbit with the perigee raised by CPS firing up to 15,000 km and the EPS is then operated on an elliptical orbit with increasing semi-major axis until the apogee reaches the geosynchronous altitude. Applicants respectfully submit that this is totally devoid of the teaching as required in claim 13 requiring the step of firing the electric propulsion thrusters to raise the orbit of the spacecraft completed upon reaching a desired on-orbit location and chemical propulsion thruster firings are interspersed with electric

thruster operation to guide the spacecraft to the final desired orbit position to compensate for disturbances experienced by the spacecraft.

The Examiner goes on to state as per claim 16, Porte discloses firing the electric propulsion thrusters to raise the orbit of the spacecraft comprises pre-planned electric thruster coast periods that are selectively shortened or lengthened in duration to compensate for disturbances on page 2, column 2. The apogee thrusting is done after a coasting period, according to the Examiner.

Applicants respectfully contend that on page 2, col. 2 there is merely taught that "The EPS is then operated continuously on an elliptical orbit with increasing semi-major axis until the apogee reaches the geosynchronous altitude." Applicants respectfully submit that this does not in any way teach, suggest or imply firing the electric propulsion thrusters to raise the orbit of the spacecraft comprises pre-planned electric thruster coast periods that are selectively shortened or lengthened in duration to compensate for disturbances experienced by the spacecraft as required in claim 16.

The Examiner has rejected claim 19 under 35 U.S.C. 103(a) as being unpatentable over Porte, p., "Benefits of Electrical Propulsion for Orbit Injection of Communication Spacecraft", in view of Tilley et al 6,186,446 as applied to claims 1, 18 and 23 above, and further in view of Hosick et al 6,032,904.

The Examiner goes on to state that Porte and Tilley et al disclose all the limitations as set forth above. Porte and Tilley et al do not disclose using gimbals to point the thrust or differential thrust away from the center of mass to provide control torque. Hosick et al, according to the Examiner, teach using gimbals to point the thrust or differential thrust away from the center of mass to provide control torque, lines 49-51, of column 7. The Examiner concludes it would have been obvious to one of ordinary skill in the art at the time the invention was made to use these teachings of Hosick et al in the invention of Porte and Tilley et al because they are the conventional ways to control spacecraft. The Examiner concludes that gimbaled thrusters are known as a way to reduce the necessary number of thrusters needed and to get the most thrust with the least amount of fuel because differential thrust can be reduced.

Applicants respectfully submit that in Hosick et al at col. 7, lines 49-51 there is merely disclosed "A secondary benefit of gimbaled electric thruster devices 22 is that it can be used to unload momentum stored in the momentum wheels 40 as described later." Applicants respectfully submit that this teaching directed to unloading momentum stored in momentum wheels does not in any way suggest, teach or imply the limitation as set out in claim 19 requiring gimbals be used to point the thrusters away from the center of mass of the spacecraft to provide control torque. Furthermore, Applicants respectfully submit that claim 19 has been shown to be patentably distinguishable over Porte and Tilley et al for

those reasons recited above with regard to claims 1, 18 and 23 above which are hereby respectfully incorporated by reference. As recited above Hosick et al does little to cure the deficiencies of this rejection.

Applicants therefore respectfully disagree that it would have been obvious to one of ordinary skill in the art at the time the invention was made to use these teachings of Hosick et al in the invention of Porte and Tilley et al because they are the conventional ways to control spacecraft and, further, that gimbaled thrusters are known as a way to reduce the necessary number of thrusters needed and to get the most thrust with the least amount of fuel because differential thrust can be reduced as contended by the Examiner.

The Examiner has rejected claim 5 under 35 U.S.C. 103(a) as being unpatentable over Porte, p., "Benefits of Electrical Propulsion for Orbit Injection of Communication Spacecraft", in view of Tilley et al 6,186,446 as applied to claim 1 above and further in view of Spitzer et al 5,595,360.

The Examiner states that Porte and Tilley et al disclose the limitations set forth above. Further, the Examiner admits that Porte and Tilley et al do not disclose the transfer orbit is supersynchronous. The Examiner goes on to say that Spitzer et al teach of using a transfer orbit that is supersynchronous at lines 65-67 of column 6. The Examiner concludes it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a supersynchronous orbit because such modification would provide longer burn time for raising perigee and decreasing inclination as stated on lines 1-5, column 7 of Spitzer et al.

Applicants respectfully submit that in Spitzer et al col. 7, lines 1-5 there is disclosed "For example, in a subsynchronous orbit, a perigee raising burn may last six out of 10 hours versus nineteen out of 22 hours for a supersynchronous orbit. Accordingly, the time of the burn for raising perigee 72 lasts longer and raises perigee 72 faster." Applicants respectfully submit that this teaching does not suggest, teach or imply the transfer orbit is supersynchronous as required by claim 5 which embraces the method recited in claim 1. Furthermore, Applicants respectfully submit that claim 1 has been shown to be patentably distinguishable over Porte and Tilley et al for reasons recited above with regard to claim 1 which are hereby respectfully incorporated by reference and Spitzer et al does little to cure the deficiencies of this rejection.

Applicants gratefully acknowledge the indicated allowability of claims 3, 9, 26 and 29 if rewritten to overcome the rejections under 35 U.S.C. 112, 2nd paragraph, set forth in the Office Action and to include all of the limitations of the base claim and any intervening claims.

Applicants note that the following is a statement of reasons for the indication of allowable subject matter: The prior art does not disclose steering the thrust vector so that the thrust vector is not normal to the axis of the solar array.

Applicants have canceled claims 3, 9, 26 and 29 without prejudice and added newly drafted claims 30, 31, 32 and 33 in accordance with the Examiner's suggestions so that said claims should be indicated as allowable.

Applicants respectfully contend that in view of the above remarks and amendments all the claims presently under prosecution have been shown to contain patentable subject matter and to be patentably distinguishable over the prior art of record, Porte, Tilley et al, Hosick et al and Spitzer et al, alone or in any combination.

Accordingly, Applicants respectfully request that this application be reviewed and reconsidered in view of the above remarks and amendments and that a Notice of Allowance be issued at an early date.

Respectfully submitted,

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